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REMOTE SENSING OF GLOBAL SNOWPACK ENERGY AND MASS BALANCE:

IN-SITU MEASUREMENTS ON THE SNOW OF INTERIOR AND ARCTIC ALASKA

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INTRODUCTION

This project began on 1 April 1987 and expired on 31 July 1994. Four major tasks have been addressed: (1) analysis of variability in the seasonal snow of interior and arctic Alaska, (2) the interpretation of microwave brightness temperature across Alaska on transects from South to North, (3) study of non-climatic controls which affect glaciers, and (4) the location of glacier facies boundaries.

1. <u>SEASONAL SNOW OF INTERIOR AND ARCTIC ALASKA</u>

Detailed study of the variability of snow cover in spruce forests and on tussock tundra was done by examining data obtained over several years, including the abnormally heavy snow of the 1990-'91 and 1992-'93 winters in interior Alaska. An overview of research on Alaskan snow cover was published by Benson (1993), and a paper by Benson and Sturm (1993) focused on Alaska's Arctic Slope, it summarized the structure and wind transport of snow, identified the major types of snow, and pointed out the need for mapping boundaries between the major wind regimes.

Our research on seasonal snow of the Arctic Slope has benefited from collaboration with several other projects these include:

(1) Research on an area studied intensively by the Department of Energy (DOE) in the northern foothills of the Brooks Range, near Toolik Lake (68° 38' N.; 149° 38' W.). This was the R4D Research Project, it included biological and hydrological research, in which the Principal Investigator was an active participant.. (R4D is the DOE acronym for Response, Resistance, Resilience and Recovery from Disturbance in Arctic Ecosystems).

(2) Hydrological research in the Kuparuk drainage basin which extends from the R4D area, just north of the Brooks Range, to the Arctic coast near Prudhoe Bay. This research, supported by NSF, is being directed by Dr. Douglas Kane of the Water Resource Center of the University of Alaska.

(3) Snow research of the USGS in connection with studies of temperature change as recorded in drill holes on the Arctic Slope of Alaska. This work is being done by Drs. Gary Clow and Arthur Lachenbruch.

(4) The Atmospheric Radiation Measurements (the ARM Program) of the Department of Energy on the Arctic Slope of Alaska. This is under the overall direction of Dr. Bernard Zak (DOE), with Dr. Knute Stamnes, of the Geophysical Institute, University of Alaska Fairbanks, in charge of the Arctic research site which is centered at Barrow, Alaska and extends out onto the Arctic Ocean and inland onto the tundra. .

We have worked to maximize communication and sharing of logistics between these projects to the benefit of all of them.

2. MICROWAVE BRIGHTNESS TEMPERATURES

The grid for microwave data (1/4° latitude and 1/2° longitude) was used on SSMI data from January through February 1989. The 59 daily records extend from the Pacific Ocean at 58°N, south of Alaska, to 73°N in the Arctic Ocean north of Alaska. They span the all-time low temperature period in January, through the all-time high temperature period in February. This juxtaposition of extremes presented an excellent case for detailed analysis. The data over land are consistent with surface temperatures but data that extend out over the ice-covered oceans are anomalous.

We investigated the anomalous brightness temperatures north of the Brooks Range (see the January 1993 report) The effects of winds may be involved in that they can create regions of less snow cover by wind erosion. The primary region of interest is near the junction of winds from the South with winds from the East and West. Regions with reduced snow cover will be accompanied by lower ground temperatures. Although the observed difference in physical temperature is less than the difference in brightness temperature, we feel that wind erosion of selected areas may be an important factor.

3. PHOTOGRAMMETRY AND LANDSAT IMAGERY USED TO MEASURE CHANGES IN GLACIER SIZE

Aerial photography was successful over the summit of Mt. Wrangell during each of the 8 years of this project. Photogrammetrical cross sections were made so that calculations of the change in ice volume within the North Crater could be done. These data are being analyzed in connection with field work extending over 30 years. The aerial photographs in 1993 were easier to work with than those of 1992 because less of the crater floor was obscured by plumes generated from fumaroles in the crater. During the past six years, the photogrammetry was paid jointly by the U.S. Geological Survey and the Alaska Division of Geological and Geophysical Surveys in cooperation with this project.

A large effort recently has gone into the analysis of ice volume changes in the North Crater of Mt. Wrangell. This has been done by working with the digital data of cross sections measured photogrammetrically. Errors caused by condensed steam clouds in the crater have been corrected by plotting data from successive years on a single graph. The condensation plumes occur in different places from one year to the next, and clear areas of one year often provide data which can be used as a guide in correcting covered intervals in the following year. The worst year for internal cloud plumes from the vocano was in 1992, the year with least interference from plumes was 1994. In 1994 there apparently was some phreatic activity at the summit on 8-9 August, 25 days after our photographs were taken on 14 July. New snow fell on the summit on 12 August and we obtained a second set of photos on 17 August which gave an excellent surface for photogrammetric analysis. We have published one paper on the photogrammetric research (Benson and Follett, 1986) and another one is in preparation.

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